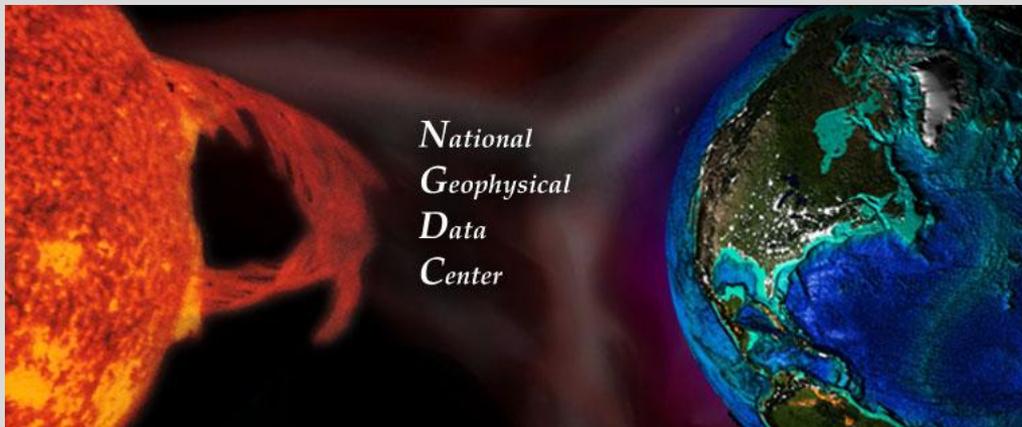


Report on Space Weather and the Geospace environment for March 07, 2012

By the NOAA National
Geophysical Data Center and the
Space Weather Prediction Center





Summary

- SkyTerra-1 operated by LightSquared provides satellite mobile voice services to many emergency responders.
- The satellite experienced an outage that began on March 07 14:43 UT.
- The outage was likely related to a Coronal Mass Ejection released from the sun on March 07 00:02 UT that created a shower of energetic protons that enveloped Earth from March 07 02:56 UT until ~March 13 18:00 UT.



In the News

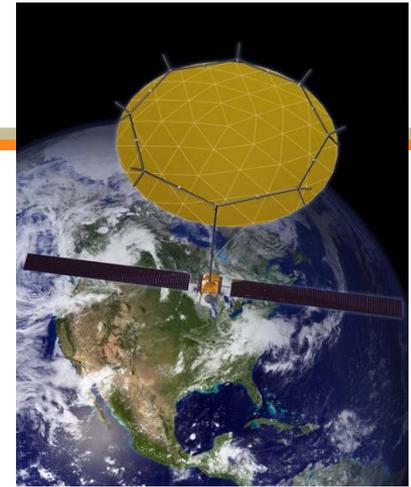
- ‘Skyterra 1 satellite has been out of service since the solar storm on March 7’

<http://mobile.slashdot.org/story/12/03/15/199252/lightsquared-satellite-disabled-by-last-weeks-solar-storm>

- Lightsquared provides mobile satellite voice and data services to North America through its SkyTerra 1 satellite launched Nov 14, 2010. SkyTerra 2 is expected to launch in 2012.

- ‘Today hundreds of thousands of devices operate using the **LightSquared** SkyTerra 1 satellite, providing reliable, ubiquitous coverage primarily for public safety, security, fleet management and asset tracking.’

<http://www.lightsquared.com/what-we-do/satellite-services/>



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Solar Flares Knock Out LightSquared Satellite As Run of Bad Fortune Continues

by Karl Bode 5 hours ago tags: satellite · business · wireless · alternatives · bandwidth · trouble · wireless

Tipped by viperadamr [E]

Earlier this week we noted that recent solar flares managed to [knock HughesNet's Spaceway 3 satellite offline](#) for a significant part of Tuesday. User viperadamr [E] writes in to note that the flares also took out LightSquared's Skyterra 1 satellite, which has been [out of service](#) since the original solar flare on March 7. The last update from the company was on [March 9](#) insisting they'd have the satellite operational again by last Sunday -- something that didn't happen. The outage arrives as LightSquared slowly stumbles toward death after [being rejected a necessary waiver](#) to operate their interference-prone hybrid LTE network.

Slashdot 🔍

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LightSquared Satellite Disabled By Last Week's Solar Storm

Posted by [timothy](#) on Thursday March 15, @03:50PM from the it's-in-the-cloud dept.

volts writes

"Troubled [LightSquared's](#) primary [Skyterra 1 satellite](#) has been [out of service](#) since the solar storm on March 7. The company says it is 'working through the rebuild of the satellite tapping into the resources that were involved in the original program.' This development follows a stream of bad news including [layoffs](#), [default on payments](#), the [resignation of CEO Sanjiv Ahuja](#) and FCC rejection of a scheme to repurpose satellite frequencies for cellular data [due to interference with GPS](#). Another kick in the teeth as company struggles to [avoid bankruptcy](#)."



Surrounding Space Weather Events

The SkyTerra outage occurred during two major space weather events that can lead to satellite malfunctions:

- 1) Geomagnetic storming at Earth due to the direct impact of a Coronal Mass Ejection (CME)
- 2) The arrival of solar protons due to the release of second CME from the sun



Sequence of Solar-Geospace Events

- **March 05 22:00 UT-** SWPC reports CME launch and predicts March 07 arrival

IA. Analysis of Solar Active Regions and Activity from 04/2100Z to 05/2100Z: An X1/2b flare occurred at 05/0409Z from Region 1429 (N17E41). This flare was associated with a full halo CME with a LASCO C3 plane of sky speed of about 1340 km/sec.

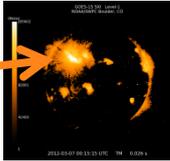
IIB. Geophysical Activity Forecast: Active conditions with a chance for minor storm periods are forecast for the second day (07 Mar) due to a expected glancing blow from todays X1/full halo CME.

- **March 06 22:00 UT-** SWPC issues forecast of possible proton events from flaring region on sun

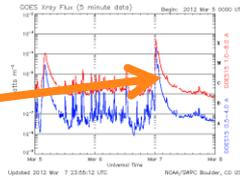
IB. Solar Activity Forecast: Solar activity is expected to be moderate...There is also a chance for a major flare and/or proton producing event from Region 1429 during the next three days (07-09 March).

- **March 07 00:02 UT-** X5 Solar flare and Earth directed CME observed

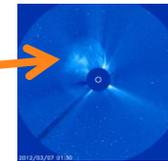
Flare seen at sun by NOAA GOES SXI



X-rays from flare seen by NOAA GOES XRS



CME seen heading toward Earth by NASA SOHO LASCO

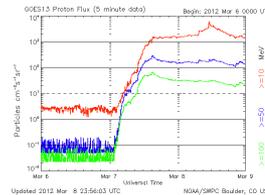


- **March 07 02:56 UT-** protons from March 07 CME arrive at Earth and SWPC issues warning

Space Weather Message Code: WARPCO
Serial Number: 54
Issue Time: 2012 Mar 07 0256 UTC

- WARNING: Proton 100MeV Integral Flux above 1pfu expected
Valid From: 2012 Mar 07 0300 UTC
Valid To: 2012 Mar 07 2359 UTC
Warning Condition: Onset

Potential Impacts: An enhancement in the energetic portion of the solar radiation spectrum may indicate increased biological risk to astronauts or passengers and crew in high latitude, high altitude flights. Additionally, energetic particles may represent an increased risk to all satellite systems susceptible to single event effects.



Protons measured by GOES

- **March 07 04:21 UT-** Earlier CME from March 05 arrives at Earth causing minor to major storm levels

- **March 07 14:43 UT-** SkyTerra Outage

- **March 09 10:45 UT-** CME launched on March 07 reaches Earth



Background

- Space weather can cause 3 types of satellite anomalies
 - Single Event Upset: Electronic malfunction caused by impact and ionization from a single energetic proton (>10 MeV)- Likely to occur when solar protons from CME generation arrive at Earth
 - Surface Charging : Low to medium energy (eV to keV) protons and electrons collect on satellite surfaces eventually causing a damaging arc-Likely during geomagnetic storm when CME impacts Earth
 - Internal Charging: Very energetic electrons pass through outer shielding and are imbed inside sensitive electronics eventually leading to sudden a damaging discharge-Likely during geomagnetic storm when CME impacts Earth



Tools for Assessment

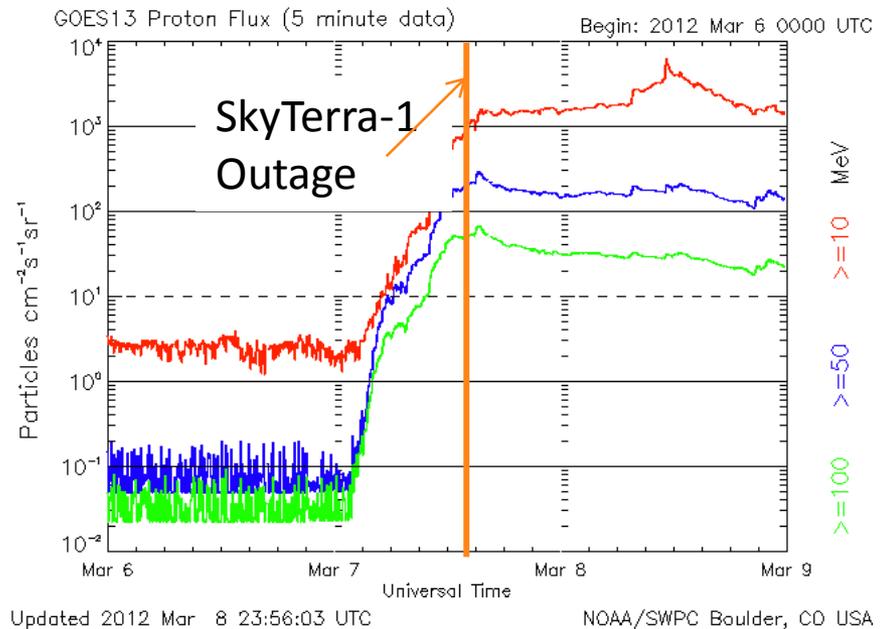
- **GOES satellite data:** NOAA operates detectors on both GOES satellites that continually monitor the levels of energetic protons/electrons in geospace.
- **Space Environmental Assessment Expert System Real Time (SEAESRT):** Product developed by the Aerospace Corporation [*O'Brien et al.*, 2009] and implemented at NGDC to turn measurements into hazard quotients for each satellite anomaly type.



Single Event Upsets

The SkyTerra outage was likely caused by a solar proton induced Single Event Upset based on GOES proton flux measurements and SEAESRT hazard estimates.

- GOES 13 data: SkyTerra-1 outage began on March 07 14:43 UT just after the flux of energetic protons increased dramatically.
- SEAESRT: Hazard estimate due to energetic protons indicates that a **single event upset was 106 times more likely** at the time of the outage.
 - The SEAESRT hazard quotient is based on the flux of >30 MeV protons measured by GOES at the time of the anomaly
 - Hazard Quotient
 $Z=(495 \text{ protons/cm}^2\text{-s-str})/4.67$





Surface Charging

Surface charging was likely **not** responsible for the outage based on the SEAESRT hazard estimate

- The SEAESRT Surface Charging hazard depends on local time and the Kp index. The local time of SkyTerra was ~8:00 and the Kp index was 6.
- Hazard=0.0095, indicating very low hazard

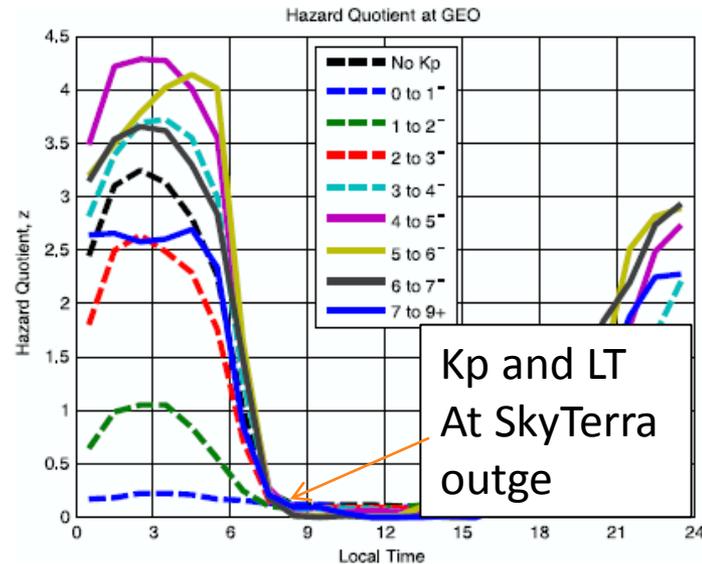


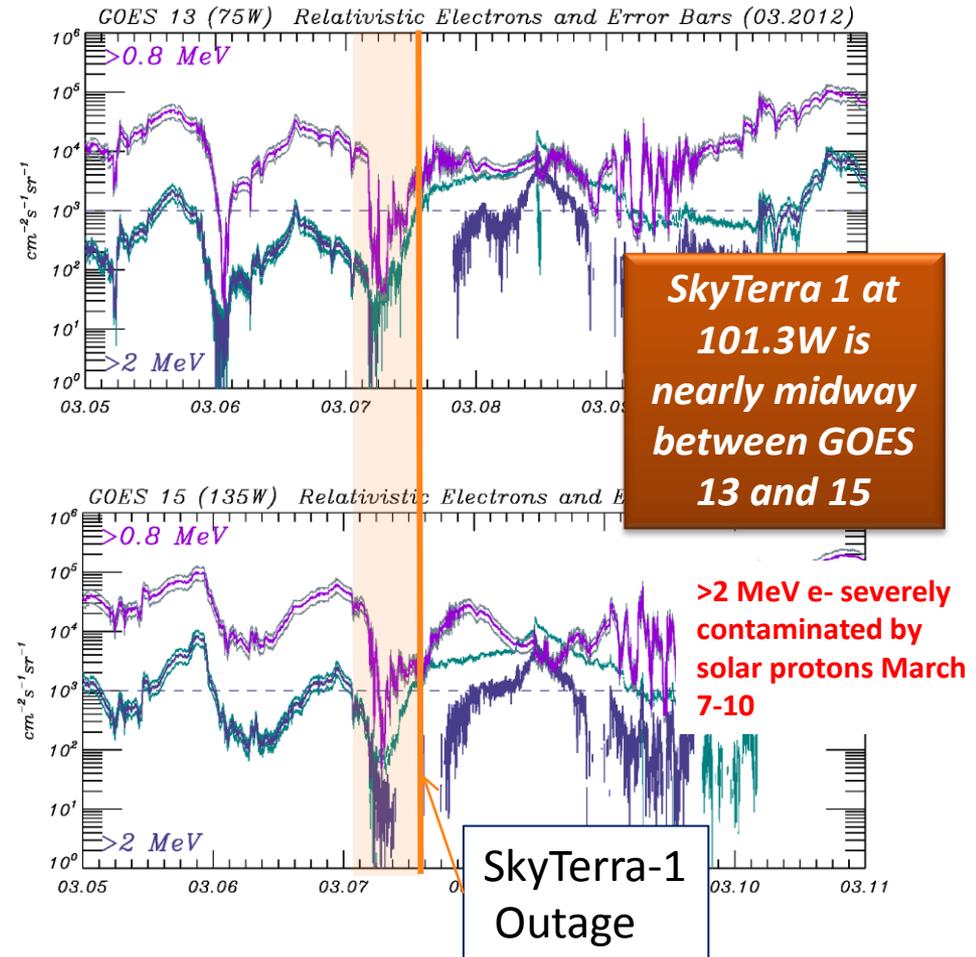
Figure 1. The surface charging hazard quotient derived from surface charge monitors on six geosynchronous vehicles for different values of Kp.



Internal Charging

Internal charging was likely **not** responsible for the outage because energetic electron fluxes measured by GOES were low

- Flux levels of energetic electrons were low during the 12 hours prior to the SkyTerra-1 outage.
- Energetic electron flux typically drops during the first part of a geomagnetic storm.





Summary

- SkyTerra-1 operated by LightSquared provides satellite mobile voice services to many emergency responders.
- The satellite experienced an outage that began on March 07 14:43 UT.
- The outage occurred during a shower of energetic solar protons that enveloped Earth from March 07 02:56 UT until ~March 13 18:00 UT that were generated by the release of a CME from the sun.
- GOES satellite measurements and the SEAESRT product confirm a high hazard for Single Event Upsets due to the solar protons at the time of the outage.